quakes. As Mr. Brigham states, "No words can convey an idea of its horrible roughness and hardness."

My own belief is that "aa" has been formed simply by obstructions breaking the quiet flow of molten lava. Every observer has noticed that "pahoehoe" contains ducts and air-chambers, having an upper crust contorted into the shape of the waves and ripples of the flowing lava. The liquid lava has evidently flowed in these ducts and chambers, and at last flowing out has left them empty with glazed interior surfaces. In like manner torrents of lava have poured through caverns down the mountains to the sea, and flowing out have left the innumerable caves, smooth and shining within, to be found all over the island. Now, when there are obstructions on the earth's surface or meeting flows, this system of ducts is broken up, and fragments of lava are carried along on the surface, piling up higher than the adjacent "pahoehoe," like ice-packs in rivers, and sometimes rolling immense boulders twenty and thirty feet high, which now stand on the "aa" with the drip glistening over them. This theory is confirmed by the fact that "aa" is always higher than the adjoining "pahoehoe," and also by the fact, which I especially noticed in the flow of 1859, that wherever there are open spaces in lava flows (kipukas), the old lava under the flow is found to be "pahoehoe" under "pahoehoe" and "aa" under "aa."

While surveying the region I was extremely interested in the arrangement of the craters; and now having determined the situation of more than fifty of them on Mauna Loa, Hualalai, and Mauna Kea, I have ascertained that there is a method in their arrangement. They are not arranged relatively to the mountain on which they are situated, but relatively to the points of the compass. There seems to have been a series of nearly parallel fissures through which these craters have risen, in lines running from S. 40° E. to S. 60° E. There are a few arranged in lines running N. 50° E.

It has been remarked by Mr. W. T. Brigham that, while the general trend of the Hawaiian group and of the major axis of each island is N. 60° W., there is no crater on the islands whose major axis is parallel to this line. "On the contrary," he continues, "a very interesting parallelism is observed among all the craters, and invariably the longest diameter is north and south." It would be more correct to say that the major axes of the great craters are generally at right angles to the general axis of the group, *i.e.* about N. 30° E. Haleakala and the ancient Kipahulu caldera appear to take the other direction, but the statement is certainly true of the great calderas of Kilauea and Mokuaweoweo, which have other points of resemblance.

Thus in both the highest walls are on the western side, and in both the action is working towards the south-west, as is indicated by the fact that the north-east craters are nearly filled up, while the deepest and active craters are in the south-west end of the caldera.

It has been shown by Prof. Dana and other geologists that the principal mountain-ranges of the globe, as well as the main coast-lines and chains of islands, take the two directions just mentioned, "which are in general tangential to the Arctic and Antarctic circles." Thus it appears that the laws in accordance with which the volcanic forces are now operating in these islands are the same as those by which all the grand features of our world have been established, and possibly related to the laws of crystallisation which pervade the mineral kingdom; and thus we perceive a unity in the processes of the globe.

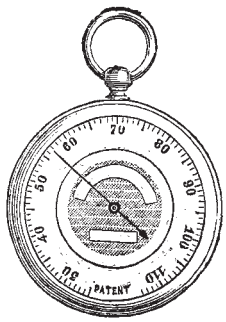
In conclusion, I would remark that to my mind the most plausible theory to account for volcanic action is that of Mallet, that the contraction of the earth's crust continually going on under the power of gravitation causes as much internal heat as would be required to cause a similar expansion. Prof. Dana has remarked that "the fact is well established that motion in the earth's rocks has been a powerful source of heat," and that the annual crushing of not over one-sixth of a cubic mile of rocks in the earth would cause all the volcanic phenomena of the world. This theory has the beauty of attributing all these phenomena to a single cause, and of thus suggesting the thought of the one great Power above the inexplicable forces of gravitation, who continues all the forces of the universe.

IMMISCH'S THERMOMETER

THIS instrument depends for its action upon the opening and closing of a minute volute Bourdon tube, which for this purpose is filled with expansive liquid and hermetically sealed. One end of the tube is fixed, and the free end is brought into contact with the short arm of a lever, the long arm of which forms a rack gearing with a pinion which carries the pointer. The position of the tube with regard to the short lever-arm is such that for ordinary purposes the divisions on the dial are equal, while for clinical use the scale is an increasing one, in order that near blood-heat the divisions become wider to permi of a fraction of a degree being read off accurately.

The success which these instruments meet with is owing principally to their sensitiveness, accuracy, and non-liability to get broken. If they should meet with an accident they can be easily repaired.

The appellation "metallic" does not seem to be a happy one for these thermometers, as they are likely to be confounded with the unsuccessful attempts which have been made to produce instruments for similar purposes by means of bi-metallic laminæ. The defects of the latter are the extremely small *vis viva* avail-



able for the work of multiplying the small motion of the laminæ, and the liability to not return to precisely the same point after being subjected to extremes of temperature. In this latter respect there is a double security with the instrument which is the subject of this notice. The tube is in itself a very flexible spring, the motion of which does not overreach the limits of perfect elasticity, and its position at any given time is determined by the volume of the liquid, which, of course, remains always a constant quantity whatever the volume may be. As the tube is absolutely full, it must of necessity always accommodate itself to the volume and correctly indicate the temperature.

As regards accuracy, we are informed that upwards of 500 have already been tested at Kew—we have ourselves seen the certificates of the last group of two dozen clinical ones, and they give the remarkable results of perfect accuracy at 66 per cent. of the points tested, and of no error greater than 0°·2 at any point on any one of the twenty-four thermometers.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, May 13.—On the theory of waves, by Prof. E. Beltrami. The author presents some considerations which place in a clearer light the process by which F. Neumann deduces the laws of Fresnel from the fundamental equations of elasticity.—Dynamics of moving systems which preserve their mutual affinity, by Prof. C. Formenti.

Rivista Scientifico-Industriale, May 31.—Maximum and relative humidity of the atmosphere, by Prof. Paolo Cantoni. Hygrometric tables of mean annual moisture, recorded at thirty meteorological stations in various parts of Italy, show that the average of maximum and relative humidity increases from north to south, from elevated to low-lying stations, and from inland to maritime districts.—On the persistence of the mathematical figure of the earth throughout the geological epochs, and on the constitution of the terrestrial crust, by Prof. Annibale Riccò. A summary is given of M. H. Faye's views on this subject already published in the *Comptes rendus* of the French Academy (March 22 and April 5, 1886), the author concluding that the mathematical figure of the globe, as represented by the surface of oceans, has not been perceptibly modified by the geological forces associated with the cooling process.—On the permanent magnetism of steel at various temperatures, by Prof. Poloni. It is shown that at the temperature of 180° C. the well-known law of magnetic distribution in steel bars no longer holds good when

the bars have been magnetised without being first subjected to great variations of temperature and kept free from telluric action by being held in a vertical position.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, June 9.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. G. F. Dowdeswell described a preparation of the microbe of rabies in the spinal cord of a rabid dog, which he exhibited × 400. — Prof. F. Jeffrey Bell exhibited a specimen (received from Prof. McIntosh) of a very young starfish, in a stage so early as to show clearly the knob-like portions of the larval organ. Prof. McIntosh has been giving some of his knowledge and skill to fishing observations, which had been rendered possible by the facilities afforded by an enlightened Fishery Board in Scotland.—Mr. F. R. Cheshire exhibited a device for the better examination of Bacteria in culture tubes, the cylindrical form of the tube so distorting the appearance of the contents that it was almost impossible to make any observations upon them under the microscope. The first plan adopted was that of placing the tube in a trough of water and then looking at it through the front of the trough. This was found to diminish the aberration very much, but it did not get rid of it altogether, and was, therefore, only available under very low powers. Water having a refractive index of about 1·333 and alcohol of about 1·374, by adding water to alcohol a mixture having a refractive index of anything between the two could be obtained according to the proportions used. Gelatine has a refractive index rather higher than that of water, and the interposition of a cylinder of glass added something to this. The trough which he employed had a front of rather thin glass, the bottom being sloped in such a way as to cause a tube placed in the trough to lie always near to the front. The tube to be examined was placed in the trough with some water, and then alcohol was added until the proper density was arrived at, and by this means it was quite possible to use a ½-inch objective effectively. —Prof. Bell, at the request of the President, gave an account of what he regarded as the most extraordinary biological fact brought to light during the last twenty-five years—that of a third eye at the top of the head of certain lizards.—Mr. Crisp called attention to a new lamp for the microscope which had been sent for exhibition by Mr. Curtis, and which was so cheap and simple that it seemed likely to become the lamp of the future. It was founded on the lamp originally devised by Mr. Nelson.—Mr. A. Brachet's communication suggesting the use of a hyperbolic lens for the field-lens of the eye-piece was read. Mr. Brachet claimed that thereby the diaphragms in the eye-piece and objective could be dispensed with, and the image much improved.—Dr. Crookshank read a paper on photo-micrography, which was illustrated by the exhibition of a large number of prints, negatives, &c. Mr. Glaisher, President of the Photographic Society, said he had examined Dr. Crookshank's exhibits, and thought they were certainly very beautiful productions. He had for many years taken a great interest in the subject of photography, and had looked to it with hopes which had been more nearly fulfilled than ever before by the specimens before them. He had heard the paper with great pleasure, and could only express his admiration of it, believing as he did that it held out great promise for the future.—Mr. F. Enock exhibited sketches of some of his slides, the various parts being numbered and named and accompanied by a short explanation. It is intended to issue sketches of all the mouth organs of British bees and other interesting insects.

Mineralogical Society, June 22.—Mr. L. Fletcher, President, in the chair.—Mr. Andrew Taylor was elected a Member. —The following papers were read :—C. O. Trechmaine, Ph.D., on barytes from Addiewell, West Calder, N.B.—Prof. E. Kinch, on plattnerite.—F. H. Butler, M.A., on dufrénite.—R. H. Solly, on anglesite from Portugal ; and on apatite from Cornwall. —Mr. R. Simpson (visitor) exhibited a very large rolled crystal topaz from Tasmania.—Several interesting specimens were re-exhibited by the President, Mr. Rudler, and others.

PARIS

Academy of Sciences, June 28.—M. Jurien de la Gravière, President, in the chair.—On the theory of minima surfaces, by M. G. Darboux. The results hitherto arrived at in the study of minima surfaces lead naturally to the inquiry here instituted regarding the determination of all minima algebraic surfaces contained in a given algebraic curve, or, more generally, to determine all the minima algebraic surfaces inscribed in a given algebraic curve.—On the subject of certain circumstances presented by the movement of the hydro-extractor, by M. de Jonquières. The author deals with the normal case (omitted by Poinsot), in which the movement of precession is complicated and rendered irregular by movements of nutation.—On a process by means of which the oscillations of an absolutely free pendulum may be mechanically counted, by M. M. Deprez. The principle is described of an apparatus not yet constructed, which is intended to record the number of vibrations without exercising any mechanical influence on the pendulum. Without this condition the results would be worthless, as the vibrations, instead of being effected under the influence of gravitation alone, would be affected by the action of a force of unknown magnitude. The problem is solved by the aid of optics, light being the only agent which exercises no mechanical action on the bodies exposed to its influence.—On the persistence of voluntary movements in bony fishes after removal of the cerebral lobes, by M. Vulpian. The author's experiments with carp fully confirm Steiner's recent conclusions regarding the persistence of the voluntary movements in fishes thus operated upon. They also show that the faculty of sight is unaffected by the operation, as already proved by the author in 1864.—On the normal metronome, by M. Saint-Saens. Owing to the defective character of this instrument, it is found to be of little practical service to musicians. Hence the Academy is urged to supply a normal metronome mathematically regulated which, before being issued to the public, should be tested and stamped like all diapasons, weights, and measures. The matter was referred by the President to the Section for Mechanics and Physics.—On the extension of a theorem of Clebsch relating to curves of the fourth degree, by Prof. Sylvester.—A fresh series of experiments on the automatic action of the regulating apparatus constructed at the Aubois sluice, by M. A. de Caligny.—On the fluorescence formerly attributed to yttria, by M. Lecoq de Boisbaudran. By recognising the complex character of yttria and announcing the existence of new elements characterised by fluorescent bands at first attributed to yttria (NATURE, June 17, pp. 160-62), the author considers that Mr. Crookes has implicitly adopted the opinion always held by him regarding the true character of these bands. But from the fresh experiments here described it is pointed out that further interesting studies will have to be made in order thoroughly to elucidate the subject.—Remarks accompanying the presentation of a work entitled "Cosmogonic Hypotheses : an Inquiry into the Modern Scientific Theories on the Origin of Worlds, with a Translation of Kant's 'Theory of the Heavens,'" by M. Wolf. In writing this work the author's object has been to show that the theory of Laplace, completed by the labours of M. Roche and other *savants*, still answers best to the conditions required of a cosmogonic hypothesis. He claims to have met all the objections urged against it, and especially that of M. Faye regarding the pretended necessity of a retrograde rotation of the planets.—Report on M. Poincaré's memoir entitled "Influence of the Moon and Sun on the Northern Trade-Winds," by the Commissioners, MM. d'Abbadie and Mascart. With certain reservations this memoir is recommended to the favourable consideration of the Academy. It shows that there is some truth in the popular opinion respecting the influence of the moon on the weather, but that this influence should be referred not to the new, but to the waning phases of the moon, while account should also be taken of the antagonistic influence of the sun.—Action of an electric current on anhydrous hydrofluoric acid, by M. H. Moissan.—On the flow of gases in the case of a permanent *régime*, by M. Hugoniot. It is shown that M. Hirn's experiments in no way contradict either the kinetic theory or the laws of hydrodynamics, and, so far from refuting, actually confirm the well-known formula of Weisbach or Zeuner.—On the condensation of vapours, by M. P. Duhem.—On the coefficient of self-induction in the Gramme machine (three illustrations), by M. Ledeboer.—On the spectra of didymium and samarium, by M. Eug. Demarçay. Some fresh results are described, which the author has obtained from the study of the photographed absorption-spectra of various products of the fractionation of didymium and samarium.—On a new double iodide of copper and ammonia, by M. A. Saglier. The process is explained by which the author has obtained this